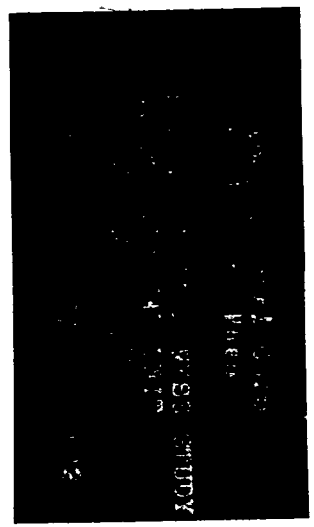

FOURTH QUARTERLY

PROGRESS REPORT

QUARTZ CRYSTAL UNIT CR-(XM-37)/U

1 APRIL 1962 to 30 JUNE 1962

CONTRACT NUMBER: DA36-039-SC-85972

ORDER NUMBER: 6027-PP-61-81-81

PLACED BY: U.S. ARMY ELECTRONICS MATERIEL AGENCY
225 SOUTH EIGHTEENTH STREET
PHILADELPHIA 3, PENNSYLVANIA

CONTRACTOR: VALPEY CRYSTAL CORPORATION
1244 HIGHLAND STREET
HOLLISTON, MASSACHUSETTS

QUARTZ CRYSTAL UNIT CR-(XM-37)/U
FOURTH QUARTERLY PROGRESS REPORT
1 APRIL 1962 TO 30 JUNE 1962

This production engineering measure on CR-(XM-37)/U quartz crystal units requires development of manufacturing techniques leading to pre-production approval in compliance with "SCS-75, TECHNICAL REQUIREMENTS", dated 28 DECEMBER 1959 and MIL-C-3098B, and the manufacture of a pilot run production in accordance with Signal Corps Industrial Preparedness Procurement Requirement No. 15, dated 1 OCTOBER 1958.

Contract Number: DA-36-039-SC-85972

Order Number: 6027-PP-61-81-81

By

VALPEY CRYSTAL CORPORATION
HOLLISTON, MASS.
Norman R. Gillin, Engineer

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ABSTRACT:

Designs for 7th overtone crystals from 150 Mc to 200 Mc are given. Results obtained using these designs are given. Problems encountered during final polish are discussed.

PURPOSE:

The purpose of this P.E.M. contract is to set up a method of manufacturing, the end result of which will be the production of acceptable quartz crystal units to "SCS-75" and MIL-C-3098B.

DETAIL REQUIREMENTS FOR THE CR-(XM-37)/U CRYSTAL UNITS:

Requirements were detailed in the First Quarterly Report.

NARRATIVE:

Using procedure as outlined in Second and Third Quarterly Report a small lot was processed at 150 Mc and at 200 Mc. No attempt was made on these lots to optomize design. We were interested in learning whether this crystal type could be made to SCS-75 and meeting resistance specification.

Our results as previously noted on Page 25 of Second and Third Quarterly Report showed that a few units at 150 Mc were under 70 ohms. At 200 Mc we were way over and there were doubts whether at these resistance figures results obtained in TS-15 were accurate.

We felt that tighter controls on final polish to frequency, to mass plating and mounting would help in lowering this high resistance at 200 Mc.

Designs for all items 150 Mc through 200 Mc were drawn up and blanks already down to .004" in thickness were started through the pin lap. Crystal Specifications are listed on Pages 12 through 16.

As previously stated, frequency checking consumed a large amount of time and the handling contributed to the extensive breakage we were experiencing.

A Frequency Counter was obtained for the lapping department. A twenty-five percent saving in time has been realized during final lapping and polishing.

As outlined in Second/Third Quarterly Report we were truing the pin lap plates by use of a Crane Lapmaster. Blanks were lapped for ten minutes and plates transferred to Lapmaster for truing. We soon discovered that the cast iron plates were not to the required flatness. Solid brass discs of the same size as the lap plates were made up and test runs started on the Lapmaster. We found day to day variations in the Lapmaster that in turn were being transferred to the lap plates.

After many weeks of recording flatness data from the brass plates we reached the conclusion that the lapmaster would true the plates to the required flatness only if the same size plates were placed on the lapmaster. Since regular production runs from other work in progress also used the lapmaster it was decided to acquire a second lapmaster to be used only on this contract. In the meantime every attempt was made to keep lapmaster in condition so that plates were within two bands over the whole surface.

Test results showed that daily variations could be from one to two bands low to one to two bands high. The end result was that lapped blanks also varied from day to day.

At the same time we were running tests on the lapmaster we accumulated data on the condition of the cast iron lap plates as the result of the ten minute runs. As data became available we realized that these runs were too long. The plates were going out of flatness so that the crystal blanks were being lapped with up to five and six

bands. Also the plates required longer runs on the lapmaster in order to restore the flatness.

The length of runs on a pair of plates was reduced one minute at a time and the resulting flatness of blanks and time on lapmaster compared. We finally arrived at a maximum of five minutes running time. This seemed to produce most consistent flatness and minimum time on lapmaster. Shorter runs required too much operator time for the quantity of blanks lapped.

During this period our operators were acquiring the "feel" of thin blanks. Losses due to handling which had been over fifty percent during lapping gradually decreased. At 150 Mc the loss in lapping was down to around ten percent. The loss at 200 Mc was around twenty-five percent. Most of this was in removing blanks, from lap, cleaning to test for frequency and replacing in lap.

Further reduction in handling time was accomplished by installing elapsed time counters on the lapping machines. Cramer Model 633-E timers were wired in so that activation of the motor starting variac also started the timers. The timers were in seconds and could be re-set after each short run or used for total time in order to lap blanks to pre-polish frequency. As the time/frequency data became available the operators were able to lap to pre-polish frequency with increased accuracy. The amount of time utilized in frequency check and scrap also decreased.

As blanks became available for polishing to frequency, data was compiled on the parallelism as viewed in monochromatic light and the individual surfaces as viewed in the interferometer.

Polishing was done on Campco covered cast iron plates. The length of runs on Campco was also reduced for the same reason as the cast iron lap plates. The time finally arrived at for Campco was a maximum of five minutes polish time and four minutes conditioning on lapmaster.

As each load was polished to frequency they were viewed in monochromatic light. All blanks from a load did not show the same degree of flatness. While most showed parallelism of less than one band, with a few being one color over entire surface, a percentage showed up to two bands and at times the bands were not concentric. Since blanks from pre-polish were frequency sorted prior to polish, a lap load could contain blanks from different runs on lap plates. It was felt that this variation could be traced to the variation we were obtaining in lapping.

It soon became evident that parallelism as viewed in monochromatic light and flatness of individual surfaces were not the same. Blanks showing parallelism of one band or less in monochromatic light were in most cases convex/concave surfaces when viewed in interferometer. It soon became evident that the polished blanks showing non-concentricity in monochromatic light were pretty acceptable surfaces in the interferometer.

As the result of this data, blanks were sent to mass plating sorted as to surfaces as viewed in interferometer and as viewed in monochromatic light. It was hoped that from this we could arrive at a pattern that would consistently produce low resistance blanks meeting resistance specification of SCS-75.

The above method of viewing polished blanks brought out the following points:

1 - Lapped blanks ready for polishing must be as flat and parallel as final polish blanks. The polish stage must not also have to correct the surfaces.

2 - The polishing pin lap machine must be in good condition. The drive pin must be as near to 90° to polish plates as possible. The drive pin must run true in carrier bushing. The correct stroke for a given pin lap must be found and maintained.

3 - Daily record of lapmaster surface condition must be maintained.

4 - Shorter time on any one set of polishing plates with constant correction on lapmaster produced the most consistent patterns.

The plating masks for all items, 150 Mc to 200 Mc, had been machined in our shop to the tightest tolerance possible. We hoped to hold down frequency spread and at the same time produce units which are near 7 pf in order to obtain lowest resistance

The spot diameter for each frequency is as shown on Pages 12 through 16.

The amount of base plating was controlled by weighing aluminum. Our monitoring method was not as yet ready to use.

Mass plated blanks were mounted in HC-18/U bases. We soon found that not all production workers were able to handle these thin blanks without excessive breakage. Skill was acquired by some, others had to be taken off the line.

The units were placed on frequency by etching as outlined in Second/Third Quarterly Report. In only a few cases did we change resistance higher by this method. Some units improved, while a large percentage did not change

Finished units were sealed and preliminary temperature testing began.

TYPICAL results of Resistance obtained on lots during this period are detailed on Pages 17 through 23.

TYPICAL results of Holder Inductance-Holder Resistance are detailed on Page 28.

CRYSTAL SPECIFICATIONS

TYPE:	CR-(XM-37)/U
FREQUENCY:	150.000 Mc 7th Overtone
TOLERANCE:	±.005%
TEMPERATURE:	-55° C to +105° C
RESISTANCE:	MAXIMUM 70 OHMS
ANGLE:	35° 27'
DIAMETER:	0.290" ±.001"
FLATNESS:	CONCENTRIC RING, MAXIMUM 1 RING
PARALLELISM:	LESS THAN 1 RING
PIN LAP FREQUENCY:	20,650 Kc ±15, -10
POLISH FREQUENCY:	21,525 Kc ±5, -10
BASE PLATE:	ALUMINUM, BY WEIGHT
SPOT DIAMETER:	.1360"

CRYSTAL SPECIFICATIONS

TYPE:	CR-(XM-37)/U
FREQUENCY:	162.000 Mc 7th Overtone
TOLERANCE:	±.005%
TEMPERATURE:	-55° C TO +105° C
RESISTANCE:	MAXIMUM 70 OHMS
ANGLE:	35° 27'
DIAMETER:	0.290" ±.001"
FLATNESS:	CONCENTRIC RING, MAXIMUM 1 RING
PARALLELISM:	LESS THAN 1 RING
PIN LAP FREQUENCY.	22,240 Kc ±15, -10
POLISH FREQUENCY:	23,255 Kc ±5, -10
BASE PLATE:	ALUMINUM, BY WEIGHT
SPOT DIAMETER:	.126"

CRYSTAL SPECIFICATIONS

TYPE:	CR-(XM-37)/U
FREQUENCY:	174.000 Mc 7th Overtone
TOLERANCE:	±.005%
TEMPERATURE:	-55° C to +105° C
RESISTANCE:	MAXIMUM 70 OHMS
ANGLE:	35° 27'
DIAMETER:	0.290" ±.001"
FLATNESS:	CONCENTRIC RING, MAXIMUM 1 RING
PARALLELISM:	LESS THAN 1 RING
PIN LAP FREQUENCY:	23,830 Kc, ±15, -10
POLISH FREQUENCY:	25,000 Kc, ±5, -20
BASE PLATE:	ALUMINUM, BY WEIGHT
SPOT DIAMETER:	.117"

CRYSTAL SPECIFICATIONS

TYPE:	CR-(XM-37)/U
FREQUENCY:	188.000 Mc 7th Overtone
TOLERANCE:	±.005%
TEMPERATURE:	-55° C TO +105° C
RESISTANCE:	MAXIMUM 70 OHMS
ANGLE:	35° 27'
DIAMETER:	0.290" ±.001"
FLATNESS:	CONCENTRIC RING, MAXIMUM 1 RING
PARALLELISM:	LESS THAN 1 RING
PIN LAP FREQUENCY:	25,650 Kc, ±15, -10
POLISH FREQUENCY:	27,020 Kc, ±5, -10
BASE PLATE:	ALUMINUM, BY WEIGHT
SPOT DIAMETER:	.1087"

CRYSTAL SPECIFICATIONS

TYPE:	CR-(XM-37)/U
FREQUENCY:	200.000 Mc 7th Overtone
TOLERANCE:	±.005%
TEMPERATURE:	-55° C TO +105° C
RESISTANCE:	MAXIMUM 70 OHMS
ANGLE:	35° 27'
DIAMETER:	0.290" ±.001"
FLATNESS:	CONCENTRIC RING MAXIMUM 1 RING
PARALLELISM:	LESS THAN 1 RING
PIN LAP FREQUENCY:	27,210 Kc ±15, -10
POLISH FREQUENCY:	28,760 Kc ±5, -10
BASE PLATE:	ALUMINUM, BY WEIGHT
SPOT DIAMETER:	.1015"

RESISTANCE DATA -CR-(XM-37)/U

150.000 Mc

LOT NO. 1 CRYSTAL UNITS NO. 86 - 123

45 OHMS	-	3 UNITS
50 OHMS	-	2 UNITS
55 OHMS	-	5 UNITS
60 OHMS	-	10 UNITS
65 OHMS	-	3 UNITS
70 OHMS	-	7 UNITS
75 OHMS	-	1 UNIT
80 OHMS	-	2 UNITS
90 OHMS	-	2 UNITS
100 OHMS	-	1 UNIT

2 NO READING

LOT NO. 2 CRYSTAL UNITS NO. 124 - 136

50 OHMS	-	1 UNIT
55 OHMS	-	1 UNIT
60 OHMS	-	3 UNITS
70 OHMS	-	1 UNIT
90 OHMS	-	2 UNITS
100 OHMS	-	1 UNIT
105 OHMS	-	1 UNIT
130 OHMS	-	1 UNIT

1 NO READING

1 BROKEN

RESISTANCE DATA - CR-(XM-37)/U

150.000 Mc

LOT NO. 3 CRYSTAL UNITS NO. 137 - 149

50 OHMS	-	2 UNITS
55 OHMS	-	1 UNIT
60 OHMS	-	1 UNIT
65 OHMS	-	1 UNIT
70 OHMS	-	3 UNITS
80 OHMS	-	1 UNIT
95 OHMS	-	1 UNIT
145 OHMS	-	1 UNIT

1 BROKEN

1 PINS TOO LARGE

LOT NO. 4 CRYSTAL UNITS NO. 150 - 163

45 OHMS	-	2 UNITS
50 OHMS	-	2 UNITS
55 OHMS	-	1 UNIT
60 OHMS	-	3 UNITS
65 OHMS	-	1 UNIT
80 OHMS	-	1 UNIT
85 OHMS	-	1 UNIT
100 OHMS	-	1 UNIT

1 NO READING

1 FREQUENCY TOO HIGH

RESISTANCE DATA - CR-(XM-37)/U

150.000 Mc

LOT NO. 5 CRYSTAL UNITS NO. 164 - 174

45 OHMS	-	2 UNITS
50 OHMS	-	2 UNITS
55 OHMS	-	1 UNIT
60 OHMS	-	3 UNITS
65 OHMS	-	1 UNIT
80 OHMS	-	1 UNIT
85 OHMS	-	1 UNIT
100 OHMS	-	1 UNIT

LOT NO. 6 CRYSTAL UNITS NO. 175 - 181

60 OHMS	-	1 UNIT
70 OHMS	-	1 UNIT
80 OHMS	-	1 UNIT
90 OHMS	-	1 UNIT
125 OHMS	-	1 UNIT
150 OHMS	-	1 UNIT

1 NO READING

LOT NO. 7 CRYSTAL UNITS NO. 182 - 192

50 OHMS	-	2 UNITS
55 OHMS	-	2 UNITS
60 OHMS	-	1 UNIT
90 OHMS	-	1 UNIT
95 OHMS	-	1 UNIT
120 OHMS	-	1 UNIT

2 NO READING

RESISTANCE DATA - CR-(XM-37)/U

150.000 Mc

LOT NO. 8 CRYSTAL UNITS NO. 193 - 205

55 OHMS	-	3 UNITS
60 OHMS	-	3 UNITS
90 OHMS	-	2 UNITS
100 OHMS	-	1 UNIT
110 OHMS	-	1 UNIT

3 NO READING

LOT NO. 9 CRYSTAL UNITS NO. 206 - 213

65 OHMS	-	1 UNIT
70 OHMS	-	1 UNIT
75 OHMS	-	1 UNIT
90 OHMS	-	1 UNIT
100 OHMS	-	1 UNIT
120 OHMS	-	2 UNITS

1 NO READING

RESISTANCE DATA - CR-(XM-37)/U

162.000 Mc

LOT NO. 1 CRYSTAL UNITS NO. 1 - 3 CULTURED

80 OHMS - 1 UNIT

90 OHMS - 2 UNITS

LOT NO. 2 CRYSTAL UNITS NO. 4 - 8 CULTURED

70 OHMS - 1 UNIT

90 OHMS - 1 UNIT

3 NO READING

LOT NO. 3 CRYSTAL UNITS NO. 9 - 23 CULTURED

78 OHMS - 1 UNIT

82 OHMS - 1 UNIT

90 OHMS - 3 UNITS

95 OHMS - 1 UNIT

110 OHMS - 1 UNIT

150 OHMS - 1 UNIT

7 NO READING

LOT NO. 4 CRYSTAL UNITS NO. 24 - 37 CULTURED

65 OHMS - 1 UNIT

90 OHMS - 1 UNIT

100 OHMS - 1 UNIT

125 OHMS - 1 UNIT

145 OHMS - 1 UNIT

150 OHMS - 3 UNITS

5 NO READING

RESISTANCE DATA CR-(XM-37)/U

162.000 Mc

LOT NO. 5 CRYSTAL UNITS NO. 33 - 42 CULTURED

90 OHMS -- 1 UNIT

4 - NO READING

RESISTANCE DATA - CR-(XM-37)/U

200.000 Mc

LOT NO. 1 CRYSTAL UNITS NO. 49 - 85

70 OHMS - 1 UNIT

100 OHMS - 1 UNIT

125 OHMS - 1 UNIT

130 OHMS - 1 UNIT

140 OHMS - 2 UNITS

150 OHMS - 2 UNITS

160 OHMS - 2 UNITS

180 OHMS - 2 UNITS

25 NO READING

CAPACITANCE DATA - CR-(XM-37)/U

150.000 Mc

LOT NO. 1	CRYSTAL UNITS	NO. 86 - 123
	Cp - 500 Kc Below	6.15 pf - 6.9 pf
	Rp - 500 Kc Below	2.4 K - 4.42 K
	Cp - 1 Mc	5.5 pf - 6.7 pf
LOT NO. 2	CRYSTAL UNITS	NO. 124 - 136
	Cp 500 Kc Below	6.4 pf - 6.8 pf
	Rp - 500 Kc Below	2.8 K - 3.6 K
	Cp - 1 Mc	5.9 pf - 6.1 pf
LOT NO. 3	CRYSTAL UNITS	NO. 137 - 149
	Cp - 500 Kc Below	6.5 pf - 6.8 pf
	Rp - 500 Kc Below	3.1 K - 4.3 K
	Cp - 1 Mc	5.9 pf - 6.1 pf
LOT NO. 4	CRYSTAL UNITS	NO. 150 - 163
	Cp - 500 Kc Below	6.4 pf - 6.75 pf
	Rp - 500 Kc Below	3.2 K - 5.0 K
	Cp - 1 Mc	5.8 pf - 6.0 pf
LOT NO. 5	CRYSTAL UNITS	NO. 164 - 174
	Cp - 500 Kc Below	5.2 pf - 6.6 pf
	Rp - 500 Kc Below	5.2 K - 15.0 K
	Cp - 1 Mc	4.9 Pf - 6.1 pf

LOT NO. 5 were mounted in standard HC-18/U bases with the mounting wires silver plated. Note change in Cp and Rp at 500 Kc Below Freq.

CAPACITANCE DATA CR-(XM-37)/U

150.000 Mc

LOT NO. 6	CRYSTAL UNITS	NO. 175 - 181
	Cp - 500 Kc Below	6.5 pf - 6.9 pf
	Rp - 500 Kc Below	2.9 K - 3.8 K
	Cp - 1.0 Mc	5.8 pf - 6.0 pf
LOT NO. 7	CRYSTAL UNITS	NO. 182 - 192
	Cp - 500 Kc Below	6.4 pf - 6.7 pf
	Rp - 500 Kc Below	3.2 K - 5.2 K
	Cp - 1.0 Mc	5.9 pf - 6.1 pf
LOT NO. 8	CRYSTAL UNITS	NO. 193 - 205
	Cp - 500 Kc Below	6.4 pf - 6.8 pf
	Rp - 500 Kc Below	3.2 K - 4.6 K
	Cp - 1.0 Mc	5.8 pf - 6.1 pf
LOT NO. 9	CRYSTAL UNITS	NO. 206 - 209
	Cp 500 Kc Below	4.0 pf - 4.1 pf
	Rp 500 Kc Below	10 K - .9 K
	Cp - 1.0 Mc	3.9 pf - 4.0 pf
LOT NO. 9	CRYSTAL UNITS	NO. 210 - 213
	Cp 500 Kc Below	6.4 pf - 6.5 pf
	Rp - 500 Kc Below	3.6 K - 6.0 K
	Cp - 1.0 Mc	5.6 pf - 6.9 pf

CAPACITANCE DATA - CR-(XM-37)/U

162.000 Mc

Cultured

LOT NO. 1	CRYSTAL UNITS	NO. 1 - 3	
	Cp - 500 Kc Below	7.0 pf	- 7.2 pf
	Rp - 500 Kc Below	2.3 K	- 2.9 K
	Cp - 1.0 Mc	6.34 pf	- 6.4 pf
LOT NO. 2	CRYSTAL UNITS	NO. 4 - 8	
	Cp - 500 Kc Below	7.2 pf	- 7.5 pf
	Rp - 500 Kc Below	2.0 K	- 3.3 K
	Cp 1.0 Mc	6.2 pf	- 6.5 pf
LOT NO. 3	CRYSTAL UNITS	NO. 9 - 23	
	Cp - 500 Kc Below	4.3 pf	- 4.7 pf
	Rp - 500 Kc Below	6.0 K	- 9.0 K
	Cp - 1.0 Mc	4.0 pf	- 4.3 pf
LOT NO. 4	CRYSTAL UNITS	NO. 24 - 37	
	Cp - 500 Kc Below	4.2 pf	- 4.6 pf
	Rp - 500 Kc Below	6.6 K	- 9.2 K
	Cp - 1.0 Mc	4.0 pf	4.3 pf
LOT NO. 5	CRYSTAL UNITS	NO. 38 - 42	
	Cp - 500 Kc Below	4.3 pf	- 4.5 pf
	Rp - 500 Kc Below	7.8 K	- 9.4 K
	Cp - 1.0 Mc	4.0 pf	- 4.2 pf

CAPACITANCE DATA - CR-(XM-37)/U

200.000 Mc

LOT NO. 1 -	CRYSTAL UNITS	NO. 49 - 85
	Cp - 500 Kc Below	5.8 pf - 6.6 pf
	Rp - 500 Kc Below	1.42 pf - 3.3 K
	Cp - 1.0 Mc	4.6 pf - 5.4 pf

HOLDER INDUCTANCE AND RESISTANCE DATA

CR-(XM-37)/U

150.000 Mc

Holder Inductance - .0183 uh - .0245 uh
Holder Resistance - 4.44 ohms - 5.66 ohms

162.000 Mc

Holder Inductance - .0180 uh - .0244 uh
Holder Resistance - 5.347 ohms - 8.588 ohms

200.000 Mc

Holder Inductance - .0167 uh - .0253 uh
Holder Resistance - 6.29 ohms - 9.78 ohms

PROGRAM FOR NEXT INTERVAL:

1 - Continuation of final polishing methods to increase yield and lower resistance.

2 - See if correlation can be established between flatness as viewed in interferometer and resistance of crystal.

3 - Control of plate back by resistance method to be studied.

4 - An attempt will be made to accumulate enough units under 70 ohms to make up pre-production lots.

CONCLUSIONS:

At this point in contract we are finding that the 70 ohm resistance figure will make manufacture of these units very difficult. So far only the 150 Mc frequency has yielded units under the maximum.

Breakage and loss has been high. Experience by personnel may reduce this.

CONFERENCES:

A conference on this Contract was held at Contractor's Plant on 10 May 1962. Present were:

Mr. Ray Woolley	-	USASSA
Mr. Ed Mason	-	USASSA
Mr. Norman Gillin	-	VALPEY
Mr. Leon Marchand	-	VALPEY

Mr. Woolley was given some samples for correlation on his equipment.

REPORTS:

No reports have been issued since Second/Third Quarterly.

MAN HOURS APPLIED ON THIS CONTRACT

DURING THIS INTERVAL

N. Gillin	76¼ hours
L. Marchand	152-3/4 hours
A. Shameklis	233-1/2 hours

DIRECT LABOR 727-3/4 hours